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A Monthly Review of Meteorology
—AND—
Allied Branches of Study.

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THE AMERICAN

Meteorological Journal.

VOL. I. DETROIT, OCTOBER, 1884. NO. 6.

CURRENT NOTES.

NOTWITHSTANDING that the earthquake of Aug. 10, in the eastern states, attracted much attention, it seems to have been very slight. That it was so insufficiently observed is due to the rarity of earthquakes in the region over which it was felt. We learn that the facts concerning it are to be collected by the National Geological Survey.

THE Electrical Conference was in session Sept. 8–13 in Philadelphia. It was founded by an act of Congress, and was composed of a Commission of twelve members and of upwards of one hundred conferees invited by the Commission. The conference thus constituted included the most of the persons in the United States who are familiar theoretically with electricity, and many of the most eminent practical electricians. Among the conferees were also many eminent English physicists, including Sir William Thomson, Professor Sylvanus Thomson, Professor Forbes, Mr. Preece, and others. The subjects of meteorological interest discussed were the relations of the Signal Service to electrical observations and the general subject of physical standards. The proceedings of the conference will be published, including the discussions, in due time by the Commission.

MR. JOHN TATLOCK, JR., whose hypsometric studies we have already noted (p. 105), has been promoted from the position of assistant at the Washburn Observatory to that of director of the new Smith Observatory at Beloit, Wisconsin. We wish Professor Tatlock a worthy career.

THE International Electrical Exhibition opened at Philadelphia Sept. 2, and will continue until Oct. 11. It is of very great electrical interest and contains some things of interest to meteorologists. Indeed we begin to believe that the scientific meteorologist must be an electrician and that there is no branch of that science which he can safely ignore. More specifically meteorological are the instruments for electric measurement, the lightning conductors, and the meteorological registers.

THE following is an extract from report of Lieut. W. L. Field, U. S. A., in charge of Branch Hydrographic Office, Maritime Exchange, New York, dated Aug. 23, 1884, and is communicated by Commander Bartlett:

"Bark Churchstarr (Br.), Capt. Adams, reports that in a voyage to Columbo, Ceylon, fell in with large quantities of pumice stone, Feb. 29th, 1884, in Lat. 18° S., Long. 73° E. Pumice stone was partly covered with barnacles."

FROM *N. E. Journal of Education*, July, 31, 1884: A singular phenomenon was witnessed at this place on the evening of July 5th. A large cloud had amassed beyond the Susquehanna, and seemed to stand like a large mountain-peak, on the summit of Peter's Mt., surrounded by a clear atmosphere. For more than an hour it was in a constant blaze from the streams of electricity which darted momentarily, like fiery serpents, in every direction within it. Often they would dart out into the clear atmosphere and branch out similar in form to the branches of a leafless tree, and often they would dart directly upward out at the top of the cloud.

This is the first time that I have seen lightning strike upward. I give the following solution of it: All the electricity in the cloud was drawn from the surrounding atmosphere, with the aqueous vapor which formed it, and in the process of formation the electricity was disengaged, and its striking out in every direction was only its returning to establish an equilibrium.

DUNCANNON, PENN., 1884. W. BROWN.

THE returns from the earthquake of Sept. 19 are not yet in with sufficient fullness to enable us to give much detail about it. It extended from Cedar Rapids, Ia., to Wheeling, W. Va., and from Grand Rapids to the Ohio River. The times of occurrence are curiously aberrant, and we think that it will be found that it was rather a series of small earthquakes differing by many minutes from each other than a tremor from a single line of disturbance. This makes it a matter of very great interest, and any of our readers who have definite information on the subject will confer a great favor on us by sending it to us, taking care so far as practicable to reduce their times to Central Standard Time.

AN old farmer gives as a result of many years' observation of sunsets, the following:

When the sun drops below the horizon free from any banks of clouds, leaving a clear red light in the western sky, fair weather may usually be depended upon for the next day.

When the sun sets in a dark cloud, or when there is a lurid mingling of red and yellow producing coppery effects in the western sky, rainy or showery weather is near at hand.

When there are broad bands of a brassy yellow at sunset, high winds may be expected within the next twenty-four hours.

When a pale green color is seen at sunset it usually indicates cooler weather accompanied by more or less of wind.

THE relative humidity is one of the most important of meteorological elements, especially in so far as concerns the relations of the weather to health and comfort. It is important that its means be correctly computed, otherwise they will lose their significance. In a recent number of the *Zeitschrift der Oesterr. Gesellschaft für Meteorologie*, (p. 265), Herr Weihrauch points out that the method of arithmetical means at present employed does not bring out the true physical mean. The relative humidity is a function of temperature and moisture combined and is expressed by $r = \frac{a}{s}$ where r is the relative humidity, a the actual amount of moisture, and s the amount of moisture for saturation at the temperature. The arithmetical mean of a series r_1, r_2, r_3, r_4, etc., is $f = \frac{\Sigma r}{n}$ when n is the number of rs and Σ the sign of summation of all the rs. But the rs stand for $a_1 : s_1$, $a_2 : s_2$, $a_3 : s_3$, etc., and the true mean of this series is $w = \frac{\Sigma a}{\Sigma s}$. When the number of observations is large, it might be

thought that, on familiar principles, f would agree with w with sufficient accuracy, but actual trial shows that this is not the case. The true mean (a) is usually less than the arithmetic one (f), and the author shows that in the particular form of function here involved this is theoretically true. This will change not only the absolute values of the means of relative humidity but also the annual and other ranges and amplitudes. Empirically it is found that the true amplitude is greater than the arithmetical. It would seem that our present method of getting the means for this element should be replaced by the better. This will involve entering in our reduction sheets a column of saturation humidities and dividing the sum of the actual by the sum of the saturation numbers. The increased labor will not be great while the results will gain much in value.

THE meeting of the American Association for the Advancement of Science, for 1884, has come and gone. The feeling is strong in the association against the formation of a new section, whether of meteorology or of any other science, and as the number of meteorological papers was not very large, the friends of the new section were not disposed to push matters. However, we believe the most of the meteorological papers were not read. Probably the interests of the science would be best promoted by the formation of an independent society. The meteorological paper which attracted the most attention was that of Professor H. A. Hazen, on the relations of thunder-storms to centers of low pressure. The paper was the result of the study of the great mass of observations which have been sent to the Signal Service during the past summer. The general result may be expressed by the statement that the southeast quadrant is the place for thunder-storms, as well as for tornados.

DURING last January I had my attention called by Mr. Jesunofsky, the observer of the Signal Service at Nashville, to a reddish brown glow which surrounded the sun. Since then I have noted it at frequent intervals, and found it nearly always more or less visible, though at some times much more so than at others. Mr. Jesunofsky said that he had observed it for some time previously to pointing it out to me, which consequently carried the first observation of it back to the vicinity of the extremely bright sunsets last fall.

When first seen by me it appeared to be of a reddish brown color, but lately it seems to have a pinkish color. The outer limits of the glow are irregular, but appear to average about 20° or 25° distance

from the edge of the sun, though sometimes projections seem to extend out 30° or more.

It seems brightest about 15° to 20° from the sun, and 8° or 10° from the sun disappears as if lost in the intense glare surrounding his margin. The phenomenon is generally best seen when clouds cover the surface of the sun himself, and thus shut off, to a greater or less extent, his overpowering light. At times I have noticed it as a dim ring around the sun, but let a small cumulus cloud hide the sun's surface and immediately it would become very perceptible as a bright pink glow, covering the whole sky in the vicinity of the sun.

It is evidently dependent on matter at a greater elevation than the highest clouds since passing cirri frequently partially obscure it.

It has been generally noticed throughout Europe, though I have seen no account given of it in this country.

Since a cloud passing over the sun's face renders the phenomenon more visible, it seems reasonable that it would become more conspicuous immediately after the sun's face became hidden by the distant hills at sunset, before the brighter tints of evening had obscured it, and probably the phenomena recorded in the following notes taken from my meteorological journal are connected with the one under consideration:

"Estill, Tenn., July 12. A suffused pink glow covered nearly the whole western sky soon after sunset. There were, however, breaks in it showing the clear sky between, with the line of separation well marked. Later it appeared as if rosy fingers rose upward from the western horizon. The tint was evidently reflected from something like cloud matter, though the sky appeared perfectly blue shortly before sunset."

"Aug. 18. From 6.45 to 6.55 p. m. a rosy band about 10° or 15° in breadth extended from where the sun had just set to the height of 45°. On the south side of this several narrower bands were seen."

"Aug. 19. The phenomenon of yesterday was repeated again to-day. The rosy bands were visible from 6.48 to 7.54 p. m., being brightest at 6.51. Five separate bands were plainly visible, with the broadest in the center."

Several times during the summer I noticed, without recording it, a rosy band several degrees in width appearing shortly after sunset and extending from a little above where the sun had just set half way to the zenith. This would remain visible something like ten minutes.

H. H. C.

THE following note from the last (July) bulletin of the Nebraska Weather Service explains itself:

"With the issue of this bulletin the connection of the undersigned with the state weather service closes. Having accepted the chair of physics in Westminster college at New Wilmington, Penn., I shall soon leave the state. The members of the service will be pleased to know that Prof. G. D. Sweezy, director of Boswell observatory of Doane college, Crete, Nebraska, has consented to take charge of the weather service for the future. The reports for August and subsequent months should be sent to him. Address Prof. G. D. Sweezy, Crete, Nebraska.

For nearly six years, amid many difficulties, the service has been carried on. It has cost in time and money a considerable amount, but has more than repaid all expenditures by the value of the statistics of our climate, which we have secured. I should have been compelled to give it up some years ago, but for the help rendered by my daughter, who for three years past has done a large share of the work. I desire here to thank all our observers for their kindly and intelligent co-operation. The system never has been in better condition than now. With the hope that the service may live long and prosper, and with the best wishes for the personal prosperity of all connected with it, I must now say adieu."

S. R. THOMPSON, Director.

THE following estimates are of interest:

DAMAGE BY METEOROLOGICAL SCOURGES, 1884.

	FROSTS.	STORMS.	FLOODS.	TOTALS.
April	$10,000	$1,250,000	$600,000	$1,860,000
May	1,500,000	615,000	6,000,000	8,115,000
June	75,000	1,250,000	1,310,000	2,635,000
Totals	1,585,000	3,115,000	7,910,000	12,610,000

This is not intended to include marine disasters in open water, but only the destruction of vessels in harbors and by storms near shore. The editor would be very glad to have any assistance in correcting, completing, or continuing this table.

AURORAS AND SYNCHRONOUS MAGNETIC DISTURBANCES IN 1883.

By J. G. Hagen, S. J., College of the Sacred Heart, Prairie Du Chien, Wis.

The observations put together in the accompanying table have been made in the following places:

Sacred Heart College, Lat. 43° 2′ 4″, Long. 6^h 4^m 32.8^s W;
Stonyhurst College (Eng.), 53 50 40 0 9 52.7 W;

while those enclosed in parentheses are taken from the second volume of the Publications of the Washburn Observatory, and were made either by Director E. S. Holden (H.) in Madison, or by Mr. F. G. T. Lueders (L.) in Sauk City, Wis.*

Stonyhurst College is intrusted with one of the five royal magnetical observatories. The instruments are set up in the cellar of a beautiful building, on stone piers, and the oscillations of the declination and inclination needles have been photographed for nearly fifteen years day and night without interruption.

The time of all the observations has, for the sake of comparison, been reduced to mean Greenwich time, the days being astronomical, *i. e.*, beginning at Greenwich mean noon.

One remarkable feature of the following table is the fact that, out of 31 polar lights, only *one* has been observed in England and here, viz., that of April 24. If this should prove a general property of auroras it might suggest the idea that they are not equally visible all around the magnetic pole, but are more brilliant in certain longitudes.

Another important fact is shown by the table, viz., that out of thirty-one auroral displays not less than nineteen are accompanied by very marked magnetic disturbances, and, indeed, the more brilliant auroras by more violent irregularities.

The auroras for which no magnetic disturbance is recorded occurred on the following days: Feb. 4, March 9, April 15, May 11 and 14, July 31, Aug. 30, Sept. 2, 3, 4 and 8, and Dec. 1. To explain this fact, it must be remembered that in the annual publications of the Stonyhurst College Observatory only the more notable disturbances are described in words, whilst the magnetograph traces are not reproduced. Indeed, the twelve auroras last mentioned are of an inferior degree of intensity, and the Stonyhurst report adds that even those were accompanied by slight irregularities in the curves.

*When this volume was received by the author, his paper was in the hands of the printer. The auroras of these Publications could therefore not be tabulated in a special column, but only inserted between the lines.

1883. Greenwich M. T.	Polar Lights Observed at		Magnetic Disturbances Observed at Stonyhurst College.
	Sacred Heart College.	Stonyhurst College.	
Jan. 25–26.....			Chief disturbance of the month.
Feb. 1			6 h. Severe magnetic storm commenced, declination and vertical force changing rapidly.
Feb 2.....			The disturbance less intense.
Feb. 4	(18 h. 20 m. Pretty bright. H.)		In the morning the magnets at rest.
Feb. 5 and 6.....			Afternoon, easterly excursions of needle.
Feb. 14 and 15...			Afternoon, magnets unsteady.
Feb. 17			Slow deviation.
Feb. 21–22.....			Considerable disturbance.
Feb. 25			Chief storm of month.
Feb. 27–28	(Moderate Streamers. L.)		Magnets very irregular.
Mar. 2	14 h.—16 h. Faint aurora, color white, no dark segment.		From Mar. 1st until the 4th magnets much disturbed.
Mar. 7–8.....			Magnets disturbed.
Mar. 9.....	Low arch beginning at 14 h., increasing toward 15 h. 20 m., no streamers or black segment.		
Mar. 12.....	21 h. Aurora of an intensely white tint, streamers very bright and in motion.		Disturbance from 16 h. 20 m. until 2 h. of the 13th.
Mar. 21–30.....	(Mar. 28. Average Brilliancy. L		Great disturbances.
April 2.....			21 h. Violent storm until the following day.
April 3.....		8 h. 40. m. White streamers in the W. 8 h. 45.—9 h. 15 m. Streamers. 10h. 12m. Increasing in brightness. 10 h. 20 m. Disappeared.	
April 15	(Average brilliancy. L.)		11 h. 44 m. Rapid easterly excursion.
April 24.....		9 h. 10 m. Cloud-like arch. 9 h. 20 m. White streamers.	From 5 h. until after 12 horizontal force much affected, vertical force most disturbed at 11 h. 30 m.

April 24.....		9 h. 10 m. Cloud-like arch. 9 h. 20 m. White streamers.	From 5 h. until after 12 horizontal force much affected, vertical force most disturbed at 11 h. 30 m.
May 11.....	14 h.—15 h. Faint, but high, streamers between E. and W.	9 h. 28 m. Reddish band. 9 h. 40 m. Faint streamers. 11 h. Just visible.	The disturbance continued on the 26th.
May 14.....		10 h. 23 m. White arch. 10 h. 28 m. Broad white band. 10 h. 45 m. Intensified. 11 h. 15 m. Decreasing.	
May 20.....		8 h. 45 m.–9 h. 15 m. Two arches of cirrus, beyond the zenith.	7 h. 5 m. Great disturbance for more than 24 hours. Rest of month quiet.
June.....			Slight disturbances on the following days; 2, 6, 17–19, 27.
July.....			Slight disturbances on the 1st, 8th, 10th, 11th and 14–27th.
July 29.....	15 h. 20 m. Streamers moving fast toward left, higher than polaris. 15 h. 35 m. Motion slower, white bank near horizon. 15 h. 50 m. Rapidly decreasing. 16 h. 4 m. Sudden start of white streamers.		Vertical force changing the whole forenoon.
July 30.....	16 h. 10 m. Decreasing. (15 h.–16 h. Low Arch.)		Vertical and horizontal force changing the whole afternoon.
July 31.....	15 h. 30 m. White aurora. 15 h. 35 m. Very bright streamers. 15 h. 50 m. Very faint. (18 h. Low arch.)		
Aug. 2.....	(17 h. 5 m. Noticed streamers *like* Aurora in the W. The northern sky had no arch, but was covered with streamers very narrow and close together. H.)		Month opened with the magnet in a troubled state, the Horizontal Force being far from regular.
Aug. 4.....	(In the zenith. Occasional str'm's. L.)		
Aug. 5.....	(Low arch, first seen 17 h. 30 m. H.)		
Aug. 6.....			7. h. Movement of magnets rapid.
Aug. 7.....	16 h. Faint auroral arch.		Movements rapid during night.
Aug. 10.....			12 h. A disturbance commenced which lasted 30 hours.
Aug. 18.....			10 h.–10 h. 33 m. Oscillations of both needles.

1883. Greenwich M. T.	Polar Lights Observed at		Magnetic Disturbances Observed at
	Sacred Heart College.	Stonyhurst College.	Stonyhurst College.
Aug. 30.....		8 h. 51 m. Arch 80° high, some very faint bands, still visible at 10 h. 30 m.	
Sept. 2.....	14h. 5m.–14h. 20m. Faint aurora. 14 h. 50 m. Increasing.		
Sept. 3 and 4....	Faint and low auroral arch.		
Sept. 5.....	(16 h. 10 m. Well defined arch. Dark segment. 18 h. 5 m. Brighter. H.)		10 h.–14 h. The first notable disturbance of this month.
Sept. 8.....		9 h.–10 h. 30 m. Auroral glow.	
Sept. 15.			14 h. 45 m. Beginning of the greatest magnetic storm of the year. 16 h. 20 m. Max. range of oscillation. 20 h. 31 m. Min. " " " Horizontal force most disturbed from 14 h. 45 m. until 22 h. Vertical force most disturbed between 16 and 20 h. In the afternoon vertical force steadily above mean. 12 h. 40 m. Vertical force violently agitated and diminished until 18 h.
Sept. 16.....	13 h. 5 m. Aurora first seen, dark segment in the N., streamers white, and moving to and fro with great intensity. 13 h. 10m. An arch extending from E. to W. rose as high as zenith. 13 h. 13 m. Its vertex south of zenith, foggy appearance, no corona. 13 h. 15 m. Disappeared and reappeared partly, motion in N. decreasing, narrow streamers rising toward zenith. 13 h. 20 m. Arch in the zenith disappeared, streamers reddish. 13 h. 30 m. All disappeared. 14 h. 10 m. Faint streamer. 15 h. 5 m. Great brilliancy with rainbow colors south of zenith, quick motion to and fro.		15h. 20m.–16h. 21m. Decl'n incr'a'd. 18 h. Vertical force resumed its normal value. 22h. 21m. Declination needle at rest.

	15 h. 5 m. Great brilliancy with rainbow colors south of zenith, quick motion to and fro.		22h. 21m. Declination needle at rest.
Sept. 18 and 19..	15 h. 35 m. Hardly anything visible.		Somewhat abnormal.
Sept. 25.....	15 h. 35 m. A few white streamers. 15 h. 50 m. Very faint arch in the north along the horizon.		From the 24th 8 h. 30 m. until the 25th 18 h. declination irregular.
Sept. 27.....			Some large oscillations.
Oct. 4...		7 h.–8 h. Auroral glow.	17 h. 25 m. Magnetic storm. Rapid oscillations of declination needle between 18 h. 25 m. and 18 h. 27 m.
Oct. 5.....		8 h. 15 m. Low arch. 8 h. 27 m. Streamers as high as 35°.	6 h. Horizontal force rapidly oscillating. Vertical force increased during the afternoon.
		8 h. 40 m. Light spreading toward E. and W. broad white streamer. 8 h. 43 m. Faint streamer. 8 h. 45 m.–9 h. Most brilliant glow. 9 h. 20 m. Tremulous motion.	
Oct. 15 and 16....			Some irregularities in the curves.
Oct. 18–19.....			Striking disturbances.
Nov. 1.....	14 h. White arch, without streamers; did not increase; must have been visible before. 15 h. 50 m. Decreasing.		Disturbance began in the afternoon and increased until the 2d.
Nov. 2....	(Average brilliancy. L.)		10 h. Horizontal force much affected. 14 h. 45 m. Minimum range of declination. 16 h. 55 m. Maximum range of declination.
Nov. 3.....	15h. 16h. White arch, no streamers.		13 h.–15 h. Minimum vertical force. 2 h. Declination needle returned to normal state.
Nov. 19–23.....			Disturbances.
Dec. 1.....	12 h.–22 h. 30 m. White arch without streamers; appearance constantly the same; seen all night.		Disturbances on the 9th, 12th and 17th.

A more detailed comparison of the single features of auroral phenomena, as the single flashes of streamers, or their tremulous motion, etc., and the simultaneous deviations of the magnetic needles cannot be made except by inspection of the magnetograph traces themselves.

SUNSPOT RECORDS.

The subject of sunspot periodicity has attracted the earnest attention of prominent scientists especially in Europe. In our own country photographs of the sun have been taken at Cambridge and Prof. D. P. Todd, of Amherst Coll., has taken a continuous series of observations since June '77. All observations, owing to the extreme difficulty of making rigid measurements, can give only an approximation to the exact surface spotted. Again clouds frequently prevent a view of the sun for days at a time, thus making a continuous series possible only by considering observations at stations far apart, and by different observers.

The measurement of spots, upon photographs of the sun, seems calculated to give the most reliable results. If however the same observer makes a continuous record for a term of years, we would have a fair knowledge of the relative frequency from month to month, though it might be impossible to make a rigid comparison of the work of two observers. In order to ascertain how nearly numbers indicating spot frequency as obtained by different observers are comparable, the following table has been compiled from various sources.

Flammarion has given in Revue Mensuelle D'Astronomie Populaire for April, 1884, a table of spot frequency, measured from photographs, in millionths of the sun's surface. To these are added Prof. Todd's observations mostly at Amherst, those of Cornillon at Arles, France; of Ricco at Palermo, Italy, and of Wolf at Zurich, Switzerland.

MEAN MONTHLY SUNSPOT NUMBERS FROM VARIOUS AUTHORITIES

MONTH.	1877.		1878.		1879.		1880.		1881.				1882.					1883.				1884.
	Flammarion.	Todd.	Flammarion.	Todd.	Flammarion.	Todd.	Flammarion.	Todd.	Flammarion.	Todd.	Cortillon.	Ricco.	Flammarion.	Todd.	Cortillon.	Wolf.	Ricco.	Todd.	Cortillon.	Wolf.	Ricco.	Todd.
January			.5	2.0	.0	.3	10.2	11.5	27.5	18.5	5.8	5.3	16.1	16.6	7.2	41.8	5.3	12.2	10.4	59.4	7.2	55.6
February....			.9	6.4	.0	.3	10.6	6.4	24.9	19.9	6.4	4.9	31.5	32.1	13.6	68.8	8.4	19.7	7.1	45.5	5.2	35.3
March.....			1.7	5.7	.6	.2	4.4	2.1	32.2	31.9	8.4	6.7	30.0	25.6	11.5	66.7	7.1	15.0	6.5	48.3	4.9	47.5
April.....			.1	.7	1.5	2.3	7.6	9.1	16.7	36.5	7.7	7.4	62.6	57.1	16.2	97.0	8.7	35.8	16.5	83.0	11.8	61.3
May.....			.9	3.7	.3	1.1	13.7	11.7	16.3	20.4	4.0	5.3	69.0	40.5	13.4	63.9	7.1	7.4	4.4	30.1	3.2	44.7
June.....	2.6	1.7	2.4	4.4	1.4	2.1	16.0	14.8	26.4	34.5	9.5	8.7	25.3	29.3	10.8	45.5	5.0	31.7	19.0	77.9	10.6	23.8
July.....	.6	.9	.6	.5	1.2	1.1	17.7	11.8	40.4	34.4	10.2	9.6	21.1	27.0	8.0	45.9	4.4	49.3	21.0	77.3	10.3	
August	1.9	1.8	.0	1.1	1.6	3.6	24.4	23.0	27.7	36.0	7.9	5.8	22.9	16.0	5.7	42.7	4.4	21.9	5.2	46.0	4.9	
September..	2.3	5.1	3.0	.2	2.5	.8	35.2	33.4	41.1	25.7	8.3	5.9	45.3	27.1	11.1	59.4	6.6	27.0	10.6	50.6	6.1	
October	6.3	2.1	.3	.4	5.5	5.3	10.4	21.4	25.0	21.5	9.0	6.5	52.5	27.4	12.4	53.9	8.3	36.2	20.3	83.1	11.4	
November..	8.6	5.6	.5	.5	5.2	5.3	18.3	15.6	40.8	19.8	9.3	7.7	74.0	28.0	15.9	84.9	9.8	33.4	19.4	82.6	11.5	
December ..	3.2	1.2	.0	.3	1.6	1.1	28.1	10.8	25.7	21.0	7.3	5.3	21.1	12.4	5.6	40.5	5.2	38.4	15.9	75.3	10.8	
Year....			.9	2.2	1.8	2.0	16.4	14.3	28.7	26.7	7.8	6.5	39.3	28.3	10.9	59.3	6.7	27.3	13.0	63.8	8.2	

These figures show in the main a gratifying uniformity in the numbers of different observers. The most serious discrepancies are in December, 1880, April, September and November 1881, and November, 1882.

The necessity of a rigid value of this periodicity will be recognized. On the one hand it is denied, that any connection has been established between disturbances on the sun and in the earths atmosphere, while on the other hand it has been claimed, that such connection exists even in the most trivial affairs.

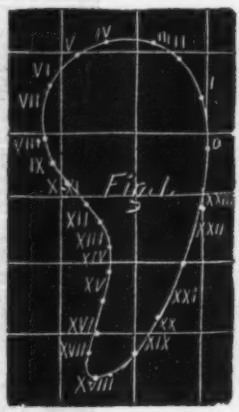
It would seem as though an attempt to study the effect of sunspots from monthly, or even daily values would be more hopeful than from yearly values.

Undoubtedly these effects are largely masked by local causes and other general forces acting at the same time with the disturbance in the sun. By a careful elimination of all known causes of variation and by a study covering a very large region, we may hope to establish the connection or at all events prove that there is none. It seems probable that if the effect were of very great consequence it would have been recognized long since. H. A. HAZEN.

ATMOSPHERIC LUNAR TIDES.

This subject has been recently studied by two Russian gentlemen, MM. Rykatschew and Belikow, from the anemometric records of the Central Physical Observatory at St. Petersburg, and their results have been published in vol. VIII. of the Repertorium für Meteorologie. M. Rykatschew classified the wind records for 1878 by lunar hours, thus eliminating, partially at least, the effects of other periodic and of non periodic winds. The results showed an apparent swing of the wind with the moon. The observed values were smoothed by Bessel's formula with the following results:

Lunar Hour.		Winter.		Year.	
		Direction of Wind.	Velocity: Kilometers per hour.	Direction of Wind.	Velocity: Kilos. per hr.
Upper Transit	0^h	S. 3° W.	0.98	S. 5° W.	0.40
	1	S. 8 E.	1.01	S. 9 E.	0.34
	2	S. 19 E.	1.01	S. 31 E.	0.27
	3	S. 28 E.	0.93	S. 62 E.	0.24
	4	S. 38 E.	0.76	N. 88 E.	0.23
	5	S. 54 E.	0.50	N. 64 E.	0.24
	6	N. 82 E.	0.25	N. 49 E.	0.25
	7	N. 11 E.	0.35	N. 23 E.	0.21
	8	N. 11 W.	0.63	N. 1 W.	0.18
	9	N. 18 W.	0.86	N. 25 W.	0.17
	10	N. 20 W.	0.99	N. 51 W.	0.17
	11	N. 19 W.	0.99	N. 45 W.	0.17
Lower Transit	12	N. 14 W.	0.94	N. 38 W.	0.16
	13	N. 7 W.	0.80	N. 18 W.	0.16
	14	S. 3 E.	0.66	N. 1 W.	0.19
	15	N. 15 E.	0.53	N. 8 E.	0.22
	16	N. 25 E.	0.39	N. 10 E.	0.22
	17	N. 32 E.	0.23	N. 5 E.	0.18
	18	N. 9 E.	0.10	N. 16 W.	0.11
	19	S. 41 W.	0.18	N. 83 W.	0.09
	20	S. 37 W.	0.40	N. 45 W.	0.19
	21	S. 31 W.	0.60	S. 32 W.	0.31
	22	S. 23 W.	0.76	S. 24 W.	0.39
	23	S. 13 W.	0.87	S. 16 W.	0.42



Remembering that the direction of a wind is the direction from which it comes, and entering these values for successive hours on a chart we find the path which would be described by a particle of air if left to the moon's influence without other disturbances. Fig. 1 represents the path for the year; Fig. 2, for the winter. The distance between the parallel lines represents one kilometer of velocity per hour. The Roman numerals are the corresponding lunar hours. The figures are taken from M. Rykatschew's article. M. Belikow investigated the records for 1879, and found it to be in substantial accord with that of 1878.

In general it appears from these studies that the lunar tide is large enough to cause an appreciable swing in the wind. This is therefore a more hopeful method for the study of the atmospheric

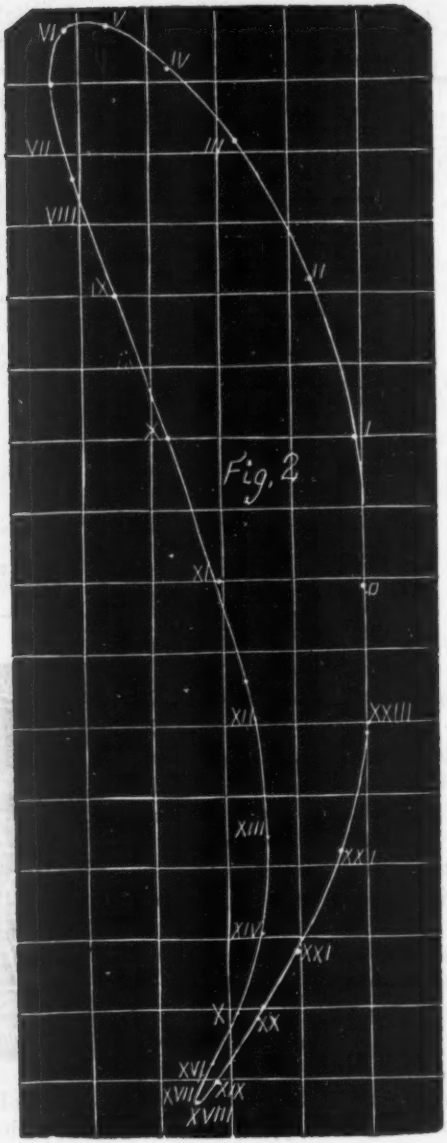

VI
V
IV
VII
III
VIII
II
IX
X
I
XII
XXIII
XIII
XXII
XIV
XXI
XV
XX
XVI
XVII
XIX
XVIII

Fig. 2

tide than that of studying the heights of the barometer directly. It also appears that while the N.–S. displacement has a single maximum and minimum in the 24 lunar hours, the E.–W. displacement has two, and this gives the orbit of displacement a palette-shape rather than that of an oval or circle. The subject is a promising one for farther study. The atmospheric tide should be fairly uniform on each parallel, and it remains to examine other cases to see if it is so. A careful determination of it will enable us also to draw conclusions on another important question, viz., the effects on the atmosphere of a body of the size and mass of the moon, these latter data being accurately known.

THERMAL BELTS.

More than twenty years ago (1861) appeared in the agricultural volume of the Patent Office Report an article on this subject from the pen of Mr. Silas McDowell, of Franklin, Macon Co., N. C. He was a man of much intelligence,and had been in youth a companion of John Lyon, the English botanist, exploring with him the Black, Yellow, Roan, Grandfather and Linville Ranges, and caring for him until his death in 1814.

Mr. McDowell was also a companion of Curtis, Buckley, Reinhardt and Dow, the latter of whom perished among the mountains, and his remains were never discovered. Dr. Gray was in communication with him more than forty years ago.

He wrote me, in 1879, being then in his 84th year, saying: "When I commenced business it was as a farmer in western North Carolina, in a wild valley and amid lofty mountains, and for nearly fifty years my house was an open free home to the scientist, particularly the geologist and botanist (my own specialties). But now the light begins to burn dim in the binnacle, and is nearly out." He died in 1882, at the ripe old age of 87. Honor to his memory!

I cannot do better than to give a description of the phenomena observed by him in his own words: "Amongst the valleys of the southern Alleghanies sometimes winter is succeeded by warm weather, which, continuing through the months of March and April, brings out vegetation rapidly and clothes the forest in an early verdure.

"This pleasant spring weather is terminated by a few days' rain, and the clearing up is followed by cold raking winds from the northwest, leaving the atmosphere of a pure indigo tint, through which wink bright stars; but, if the wind subsides at night, the succeeding morning shows a heavy hoar frost; vegetation is utterly killed, including all manner of fruit germs, and the landscape clothed in verdure the day before now looks dark and dreary.

"It is under precisely this condition of things that the beautiful phenomenon of the "Verdant Zone" or "Thermal Belt" exhibits itself upon our mountain sides, commencing at about three hundred feet vertical height above the valleys, and traversing them in a perfectly horizontal line throughout their entire length, like a vast green ribbon upon a black ground.

"Its breadth is four hundred feet vertical height, and from that under, according to the degree of the angle of the mountain with the plane of the horizon. Vegetation of all kinds, within the limits of this zone is untouched by frost; and such is its protective influence that the Isabella, the most tender of all our native grapes, has not failed to produce abundant crops in twenty-six consecutive years; nor has fruit of any kind ever been known within these limits to be frost-killed, though there have been instances where it has been so from a severe freeze. The lines are sometimes so sharply drawn that one-half of a shrub may be frost-killed while the other half is unaffected.

"This belt varies in the height of its range above different valleys. I will name a case in point. I made my observations in relation to this belt in Macon Co., N. C., which is traversed by the beautiful valley of the Little Tennessee river lying 2000 feet above tide water. Here, when the thermometer is down to 26°, the frost reaches 300 feet vertical height. A small river, having its source in a high plateau 1900 feet above this, runs down into this valley breaking through three mountain barriers, and consequently making three short valleys including the plateau, rising one above the other, each of which has its own vernal zone, traversing the hillsides that enclose them, the first of which takes a much lower range than that of the lower valley, and each taking a lower as the valleys mount higher in the atmosphere, and in the highest one the range of the belt is not more than 100 feet above the common level of the plateau, a beautiful level height containing 6000 acres of land and lying 3900 feet above tide water.

"The country on the Atlantic side of the Blue Ridge sinks rapidly by a succession of long sunny slopes reaching down into the plain or level country. Along these slopes the air is pure and dry, a refuge for the consumptive, as diseases of the lungs have never yet been known to originate among the inhabitants of these dry fog-less mountains, and here also does the grape find a most salubrious climate and congenial home.

"The thermal belt must exist in all countries that are traversed by high mountains and deep valleys, as the natural causes that produce it are as infallible as those which produce the rainbow in the clouds, and the only reason why its visible manifestations are peculiar to our southern Alleghanies is the fact that their precocious spring vegetation is sometimes killed by frost, while the same thing does not happen in the mountains further north."

Another similar belt is found along the eastern slope of the Tryon Mountain range in Polk Co., N. C.

Says Dr. L. R. McAboy, of Linn, in this county: "The belt along Tryon Mountain is some eight miles long and extends from 1200 feet above tide water to 2200 feet, thus being about 1000 feet in width. This begins at the very base of the mountain, and extends up till you have attained the full height of the Blue Ridge, say of Asheville, Buncombe Co., with an elevation where the belt is most perfect, of about 1500 feet.

"The observed facts of temperature are truly strange. The mercury falls in summer and rises in winter, when compared with either the top or the base of the mountain, so much so that travellers on the highway through the belt perceive the difference without the aid of a thermometer. This difference is greater at night than during the daytime, being 5°–10° on the summer nights, and 15°–20° on winter nights. There is very little dew, generally non perceptible, which accounts for little or no frost.

"The flora is grand. The Azalea there, instead of being a shrub four feet high, attains a hight of 10–20 feet, and exhibits every shade of pink and orange.

"We are in lat. 35°, but are for all practical purposes 8° south of our geographical position. The leaves of plants, shrubs and flowers remain untouched by frost until the latter part of December, and sometimes till the middle of January, when they are killed by snow or sleet. The early spring in the belt admits of planting any vegetables the first of February without risk from frost. Tomatoes, tobacco and other tender plants remain green until after the middle

of December. Fig trees live through the winter unprotected, and bear full crops, while in the valley they are killed to the ground every winter. Grapes never mildew nor rot, and are of large size and delicious flavor. This belt is confined within distinct and well defined limits, which remain the same from year to year, and in the middle stratum of air or land on the mountain side."

Another writer says: "After a snow-storm not a particle of snow will exist in the belt (it melts as it falls), while the tops and sides of the mountains above, and the valleys below, will be covered."

Prof. John Le Conte (*Science*, vol. 1, p. 278) says: "I wish to put on record the results of observations made by me many years ago, on the "frostless zones" of the flanks of the mountain spurs adjacent to the valleys in the Blue Ridge. My observations were made at Flat Rock, near Hendersonville, Henderson Co., N. C.,—a well-watered, fertile, mountain-plateau-like valley, which is about 2,200 feet above the sea-level.

"My own observations,and the information elicited from residents, seem to indicate the following facts: The zones in question are not exempt from frost during the whole of the cold season; in fact, during the winter, the ground in these belts is frequently frozen to a considerable depth; but during the spring months they are conspicuously and uniformly frostless."

It seems then to be an established fact that at these three points, in three different counties, there are some noteworthy meteorological conditions prevailing along this belt of 400 to 1000 feet of perpendicular height, and it seems probable that a similar state of things exists in kind, if not in degree, on all the southern and eastern slopes of parallel mountain ranges in that latitude where protected against wind.

As to Mr. McDowell's assertion that "The thermal belt must exist in all countries traversed by high mountains and deep valleys" it is and will be matter of interest for observers in such situations to corroborate or disprove,and this is our object of the presentation of this paper at this time.

Respecting the explanation of these phenomena, Mr. McDowell theorizes as follows: "Heat is ever radiating from the earth, and in cold, clear, still nights it mounts upward through the cold damp air, taking from it its caloric, while the latter rushes down in a cold frost-producing current, and hence the lowest ground in a valley is ever subject to the hardest frosts.

"The warm, dry, light current keeps mounting upward like cork in the water, until it reaches a stratum of atmosphere too thin and light to support it, when it consequently falls back and pours its warm dry genial stratum upon the top of the lower or frost stratum; and hence on cold frosty nights is produced the phenomenon of the 'Vernal zone.'"

Of course such a phenomenon must be explained in general upon the theory of the nocturnal stratification of layers of the atmosphere, having different amounts of moisture and caloric, of which we so often see examples when the mist settles in the valleys at a given level, which if the temperature be sufficiently low, would also be the frost line, or when often on a summer's day from a mountain top, the white cumuli may be seen stretching away in long lines at a well defined altitude. But in these cases we have no such visible and exact demarcation of the warmer stratum on its upper side.

Prof. Le Conte in an article already quoted from says: "The 'frostless zones' *coincide* with the nocturnal and morning 'fog-belts' of the spring months. The uniform pressure of these white circumscribed belts of fog on the flanks of the mountain spurs, during the early morning hours, imparts a striking feature to the scenery of these valleys. When illuminated by the bright morning sun, they appear like girdles of cotton-wool of moderate width, encircling the peaks at the height of 200 or 300 feet above the adjacent valleys; and their cumulus-like whiteness, contrasted with the verdure above and below them, is no less striking than it is beautiful."

The latter circumstance seems to furnish an explanation of the physical course of the so-called "Thermal Belt;" for the constant fogs at night and in the morning not only prevent refrigeration by obstructing terrestrial radiation, but during the condensation of vapor in the process of fog-formation, there must be developed an enormous amount of heat just at this zone. Why this condensation of aqueous vapor should be so persistently restricted to a belt of only a few hundred feet in vertical thickness, is a question much more difficult to answer. The observations of intelligent residents of the mountain valleys in the southern divisions of the Appalachian chain will doubtless verify or disprove the general *coincidence* of the "frostless zone" with the "fog-belt,"

Mr. J. W. Pike, of Vineland, N. J., in a newspaper article, speaks of having observed the same phenomenon while camping

among the mountains of California, that during the night the cold was much greater in the valleys than on the terraces several hundred feet above.

His explanation is that, as the air becomes chilled by contact with radiating surfaces, it settles to the lowest possible level, and then accumulates forming lakes of cold air, which flow slowly down the slopes of the valleys, filling all depressions, so that a process of aerial drainage into valley reservoirs is continually going on, and in a succession of mountain valleys, each would have its own lake and river of cold air, so long as there was no wind to cause a mingling of the different strata.

On this river of cold he supposes the warmer air to float forming a stratum or belt until it reaches a height above at which the expansion of the air from diminished pressure, causes a fall of temperature till the freezing point is reached.

"As the winter advances, this upper zone of cold due to expansion will travel downward and extinguish the thermal belt of each valley in succession, so far as the absence of frost is concerned, but on clear still nights, the thermometer will reveal the three belts as before, whether in winter or in summer."

This Piedmont region, not merely that section technically so-called, but the zone along and around the southern Appalachians having an elevation of from 1000 to 2500 feet obove sea-level, possesses attractions as regards beauty and grandeur of scenery, fertility and variety of soil, equability and salubrity of climate, not to be surpassed in the Union.

If in addition these thermal belts exist, and extend generally among those ranges, offering exemption from certain forms of disease, with exceptionally favorable facilities for fruit culture, a knowledge of the facts should be more generally diffused.

To the meteorologist, the physician, the botanist, the fruit grower, and the friend of humanity in general, these alleged facts are full of interest, and are certainly worthy of more accurate and reliable observation and investigation, and, if verified, of scientific explanation.

It is to be hoped that we may at some future time have a series of simultaneous and continuous thermometrical and hygrometrical observations at different points, within and without these belts, throughout the year, to show the actual difference in temperature and moisture and the limits of the belt.

National Deaf-Mute College, Washington, D. C. J. W. Chickering, Jr.

RECENT DISCOVERY OF THE TRUE SOURCE OF THE MISSISSIPPI RIVER.

By Captain Willard Glazier.

CHAPTER III.

HOME OF THE CHIPPEWAS.

Upon our arrival at Leech Lake our first glimpse of the embryonic red man was of a boy about six years of age, who ran out of a wigwam—his copper-colored skin unadorned by a single garment—brandishing a bow in one hand, and carrying arrows in the other. He was very far from being warlike, however, and on seeing his white brothers suddenly disappeared in the bushes. A little further on we came to several wigwams, and finally to a log cabin, over the door of which was nailed a pine board, bearing the inscription: "Hotel." Here we were received by a rough-looking man with long hair and unkempt beard, and wearing in addition to his one other article of clothing a pair of pants made from a red blanket.

The prospect was certainly not an inviting one, and no reason was found for forming a more favorable opinion when we had alighted and inspected his squalid accommodations. But as the government officials were away from the post, we accepted the situation, and as graciously as possible placed our names, figuratively speaking, on the register of the Weaver House. We fared much better than we expected, however, dining on fresh fish and potatoes. Our supper and breakfast were selected from the same bill of fare, varied by the addition of "flap-jacks." As a substitute for habitable beds we swung our hammocks from the rafters of the loft.

Leech Lake is one of the most irregularly shaped bodies of water that can be conceived of. It is neither characteristically long, circular nor broad, but rather a combination of curves, peninsulas and bays, of which nothing short of a map can convey an accurate idea. Ten islands are found within its bosom, and seven rivers and creeks enter it from various quarters. It extends from north to south not less than twenty miles, and from east to west a still greater distance, with a coast line of nearly four hundred miles. Its waters are deep and clear in all its central parts, and yield the white fish, bass, pickerel and other species. Its numerous and extensive bays abound in wild rice, and attract in the proper season

a great variety of water fowl. The pelican, swan, brant and cormorant are the largest of the species that annually visit it. On its shores may be found the elk, deer and bear. Beavers were formerly abundant, but they have in a great measure disappeared. The mink and muskrat are now the principal items of its fine furs. Such a lake in the midst of a hunting and trapping country is always considered a place of importance, and nearly a hundred years ago Canadian fur traders came through the forests and over the lakes and rivers from Montreal to establish a trading post at this point.

For many years Leech Lake was the seat of the Chippewa Indian Agency, but the latter is now consolidated with the White Earth and Red Lake agencies. Major C. A. Ruffe, is at present agent of the three departments, with head quarters at White Earth. The village on Leech Lake consists of a half dozen government buildings, as many log cabins, and twenty or thirty wigwams, scattered here and there over one of the arms of the lake.

The day after our arrival the Agency was thrown into a state of excitement by the announcement that Major Ruffe was en route to Lake Winnibegoshish by way of Leech Lake, and that he was expected to make his advent on the afternoon of the following day. The Major was accompanied by Captain Taylor, of Saint Cloud, one of the pioneer surveyors of Minnesota; Paul Beaulieu, the veteran government interpreter, and White Cloud, chief of the Mississippis.

Major Ruffe was untiring in his efforts to relieve the monotony of our sojourn at the Agency, and to render our condition as agreeable as possible while within the boundary of his dominions. Through conversations with this genial gentleman I learned much of the pioneer history of the post, and the attempts to civilize the Pillagers, as the Leech Lake Indians are styled. This band seems to have separated from the other Chippewas at an early day, and to have taken upon themselves the duty of defending this portion of the Chippewa frontier. They "passed armed before their brethren" in their march westward. Their geographical frontier was one which required them to assume great responsibilities, and in the defense of their chosen position they have distinguished themselves as brave and active warriors. Many acts of intrepidity are related of them which would be recorded with admiration had white men been the actors.

Perfectly versed in the arts of the forest, they have gained many victories over that powerful assemblage of tribes known as the Sioux.

With fewer numbers the Chippewas have not hesitated to fall upon their enemies, and have defeated and routed them with a valor and resolution which in any period of written warfare would have been stamped as heroic. It is not easy on the part of the government to repress the feelings of hostility which have so long existed, and to convince them that they have lived into an age when milder maxims furnish the basis of wise action. Pacific counsels fall with little power upon a people situated so remote from every good influence, and who cannot perceive in the restless spirit of their enemies, any safeguard for the continuance of a peace, however formally it may have been concluded. The fact was adverted to by one of their chiefs who observed that they were compelled to fight in self defense. Although the Sioux had made a solemn treaty of peace with them at Tipisagi in 1825, they were attacked by them that very year, and almost yearly since sustained insidious or open attacks.

The domestic manners and habits of a people whose position is so adverse to improvement, could hardly be expected to present anything strikingly different from other erratic bands of the Northwest. There is indeed a remarkable conformity in the external habits of all our northern Indians. The necessity of changing their camps often, to procure game or fish, the wants of domesticated animals, the general dependence on wild rice, and the custom of journeying in canoes, have produced a general uniformity of life. And it is emphatically a life of want and vicissitude. There is a perpetual change between action and inanity of mind which is a striking peculiarity of the savage state. And there is such a general want of forecast that most of their misfortunes and hard ships, in war and peace, come unexpectedly. None of the tribes who inhabit this quarter can be said to have, thus far, derived any peculiarities from civilized instruction. The only marked alteration which their state of society has undergone appears to be referable to the era of the introduction of the fur trade, when they were made acquainted with and adopted the use of iron, gunpowder and woolens. This implied a considerable change of habits, and of the mode of subsistence, and may be considered as having paved the way for further changes in the mode of living and dress. But it brought with it the onerous evil of intemperance, and left the mental habits essentially unchanged. All that related to a system of dances, sacrificies, and ceremonies, which stood in the place of religion, still occupies that position, presenting a subject which is claimed to be the peculiar

work of teachers and evangelists. Missionaries have been seen to avail themselves of this field of labor, and it should not excite surprise that the Chippewas are to so great a degree mentally the same in 1882 that they were on the arrival of the French in 1532.

It was a subject of much regret that my arrival at Leech Lake was at a season when the Pillagers were away upon their annual hunting and fishing excursions. Their absence from the Agency was a serious obstacle in the way of our further progress. Being compelled to take the final step in my expedition to the source of the Mississippi from this point, it was important that I should complete my equipment by securing an interpreter, reliable guides, and birch bark canoes.

Conversations with Rev. Edwin Benedict, the Post Missionary; and Flat Mouth, head chief of the Chippewas, developed the fact that they knew of but one Indian in the Chippewa country who had actually traversed the region which I was about to explore, and that he was then visiting some friends near Lake Winnibegoshish, and was not expected to return until the following Saturday, some three days hence.

Satisfied that Che-no-wa-ge-sic would prove indispensible to the success of my expedition, I decided to await his return to the Agency.

The tedium of my sojourn at Leech Lake was broken by a dinner with Flat Mouth, a visit to the Missionary, and a conversation with Paul Beaulieu concerning the source of the Mississippi.

Although for many years I have been much among the natives of the forest, my dinner with Flat Mouth was the first instance of a meal with Indian royalty.

Flat Mouth, the present ruler of the Pillagers, is a descendant of Aish-ki-bug-ekozh, the most famous of all the Chippewa chiefs. He is stalwart in appearance, and is endowed with talents which certainly entitle him to this distinction. Having accepted his invitation to dinner, I went to his residence at the appointed hour, accompanied by my brother. I found him living in a comfortable log house of two rooms, well floored and roofed, with a couple of small glass windows. A plain board table stood in the center of the front room, upon which the dinner was spread. Pine board benches were placed on each side of the table and at the ends. We followed the example of our host in sitting down. Five other persons, including his wife, were admitted to the meal. The others were White Cloud, chief of the Mississippis, and three Chippewa sub-chiefs.

The wife of Flat Mouth sat near him, and poured out the tea, but ate or drank nothing herself. Tea cups and tea spoons of plain manufacture were carefully arranged, the number corresponding exactly with the expected guests. A fine mess of bass and white-fish, cut up and boiled in good taste, occupied a dish in the center of the table, from which he helped us. A birch bark salt cellar, in which pepper and salt were mixed in unequal proportion, allowed each the privilege of seasoning his fish with both or either. Our tea was sweetened with the native sugar. A dish of blue berries, picked on the shore of the lake, completed the dinner.

I was much gratified on this occasion by the presence of White Cloud, whom I had frequently been told was the most respectable man in the Chippewa country, and if the term was applied to his intellectual qualities, and the power of drawing just conclusions from known premises, and the effects which these have had on his standing and influence with his own tribe, it is not misapplied. Shrewdness and quickness of perception most of the chiefs possess; but there is more of the character of common sense and practical reflection in White Cloud's remarks than I remember to have noticed in most of the chiefs of my acquaintance. In his early life he was both a warrior and a counselor, and these distinctions he held not from any hereditary right, but from the force of his own character. I found him quite ready to converse upon the topics which were of most interest to him. And the sentiments he uttered were such as would occur to a mind which had possessed itself of facts, and was capable of reasoning from them. His manners were grave and dignified, and his oratory such as to render him popular wherever heard.

During the repast the room became filled with Indians, apparently the relatives and intimate friends of Flat Mouth, who seated themselves orderly and silently around. When we arose, White Cloud assumed the oratorical attitude, and addressed himself to me.

He expressed regret that his white brothers had been so long in ignorance of the source of the Mississippi, and said, although he had not himself seen the head of the Great River, there were many braves of his tribe who were familiar with its location. He hoped I had come thoroughly prepared to explore the country beyond Lake Itasca, and that I would not return to my friends until I had found the true source of the Father of Waters. Continuing, he said: "I am told that Che-no-wa-ge-sic, the Chippewa warrior will accompany you. He is a good hunter and a faithful guide. He can

supply you with game, and paddle your canoe. The Chippewas are your friends, and will give you shelter in their wigwams."

"Find Rev. Edwin Benedict as soon as you reach Leech Lake," was the last injunction I received on leaving Brainerd. Mr. Benedict is one of the five missionaries of the Episcopal Church on the Chippewa Reservation, and holds his commission from Bishop Whipple, of Minnesota. With this pleasant gentleman I spent the greater share of my time while at the Agency, when not engaged in preparations for my voyage. The courtesy of a civilized bed, and a table with paper, pens and ink, were luxuries which will not soon pass from my memory.

Paul Beaulieu, the half-breed interpreter to Major Ruffe, possesses a fund of information concerning the upper Mississippi which cannot be consistently ignored by those who are in pursuit of its mysterious sources; and I considered myself most fortunate in meeting him before my departure for Lake Itasca.

Beaulieu deserves more than a passing mention, as he is a man of large experience, and is well known throughout Minnesota, and in some circles througout the country. He was born at Mackinaw while General Sibley was stationed there in the interest of the American Fur Company, of which John Jacob Astor was then the head. His father was a Frenchman, and his mother an Indian. He received a liberal education partly in the Government school at Mackinaw and partly at Montreal. On leaving school he was employed by the Fur Company and sent all over the United States, from the Saint Lawrence to Lower California. He crossed the continent with the Stevens party on the first Northern Pacific survey, and rendered such valuable services that he was presented a testimonial in recognition of his efficiency.

Beaulieu had a theory of his own regarding the source of the Mississippi, based upon the stories of Indians of his acquaintance. Referring to this subject, he said that to the west of Lake Itasca there was another lake, the outlet of which unites with the stream from the former lake, and which contributes a much larger volume of water at the junction than the outlet of Itasca. He therefore assumed that this nameless and almost unknown lake was the true source of the Mississippi.

In corroboration of the Beaulieu theory, Major Ruffe said that he had heard the same idea expressed by a number of old Indian voyagers. It will thus be seen that there was a great diversity of opinion among the most reliable authorities as to the actual source of the Great River. *(To be continued.)*

SOLAR HEAT AND TERRESTRIAL DILATABILITY.

By Sr. F. D. Covarrubias.

II. Geodetic Measurements.

We said, at the beginning of this memoir, that it was in examining the differences between the arcs of the meridian, such as resulted from direct measurements, and their values obtained by calculation, that the idea first came to us that the effect of the distribution of heat upon the earth was, perhaps, not to be neglected.

The celebrated astronomer Bessel is one of the geometricians who have been occupied in the discussion of the principal geodetic measurements to deduce from them the most plausible values of the radius at the equator, and of the eccentricity of the terrestrial meridians, on the supposition that the earth is, nearly, an ellipsoid of revolution. The elements deduced from the discussion of Bessel have been generally considered as the most suitable to represent, in their entirety, the results furnished by geodetic operations. And really, when we calculate with these elements the lengths of degrees of the meridian at different latitudes and then compare the results of the calculation with those of direct measurements, we find the differences quite small, especially if such a comparison takes place between the same arcs which have been employed in the discussion, viz., the ten most worthy of confidence. Without pretending to deny, however, that the elements of Bessel are those which accord best with the results of experiment, we believe we have found, in the differences which we have just mentioned, a certain law of variation which seems to accord with the diminution of temperature, at least when we abstract the little accidental irregularities and consider only the whole.

There is still another very remarkable fact. The numerous measurements of the pendulum beating seconds which different observers have made over the whole earth, and the combination of which furnishes also the flattening or eccentricity of the globe, give for this element a larger result than the geodetic measurements; and it is worthy of remark that observations with the pendulum are, in general, more in accord with each other than are the results of geodetic operations. The first produce a flattening which may be estimated, in mean terms, at $\frac{1}{310}$, with small variation in this number; while the second, with the arcs employed, give results from $\frac{1}{300}$ to $\frac{1}{313}$. The value obtained by Bessel is nearly $\frac{1}{299}$.

The measurements with the pendulum make the earth notably more eccentric than the geodetic measurements. If we remember that the first may be considered as entirely independent of the effects of dilatation and consequent elongation of equatorial degrees and shortening of degrees measured in high latitudes, we get a glimpse of the possibility of arriving at a more perfect accord in the results of these two kinds of operations. This can be reached by means of the evaluation of the effects of temperature in the different countries in which have been executed the geodetic works which have served as the base of our own actual knowledge of the figure and dimensions of the earth.

The exact resolution of this difficult problem would demand: 1st. The knowledge of the coefficient of dilatation of the soil in each country, or better, in the places where the bases of geodetic triangulation have been measured. 2d. That of the temperatures of the soil during the measurement. 3rd. The certainty that all the geodetic and astronomic operations are free from error, in order to have the right to attribute to the one effect of different temperatures the respective differences between calculation and observation. 4th. The certainty that there exist no local perturbations, or abnormalities in the general figure of the terrestrial globe.

These two last suppositions are entirely inadmissible; and as to the first given, it would be only possible to obtain them with sufficient precision, by means of observations executed in the respective localities, making them in the seasons in which the measurements took place.

But in spite of our ignorance of all these elements, as our object is not precisely that of obtaining the true figure and dimensions of the earth, but more to see if the consideration of the temperature would make the calculations accord better with the geodetic observations, and these results with those of the measurements by the pendulum, we think we might undertake the solution of the problem by making use of approximate data. In effect, the dilatability of the soil, always relatively small, need not be very different in one country from that in another, since the constituent substances of the soil are everywhere nearly the same; and as the temperatures at the time of the measurements are not known to us, we may replace them by mean temperatures of the air at each locality.

We understand well that this last element would necessarily be incorrect, not only because the temperature of the soil is almost always different from that of the air, but also because the former varies much from one season to another, especially in high latitudes. If any measurement has been made during an extremely cold epoch, or in an extremely warm one, there will be in the data employed an error equal to the difference between the mean and that extreme temperature. Notwithstanding, as it is not possible to avoid that inconvenience, we feel ourselves encouraged by the consideration, that it is a fact continually verified by experience, that the effects of constant causes, manifest themselves at the end, even when for the moment, and in a small number of observations, they may seem concealed by the variable effects of fortuitous circumstances. It is precisely what ought to happen in the nearly insensible phenomena of dilatability. In them we may hope for a certain compensation, in combining many observations, instead of employing only the number strictly necessary for the determination of the unknown quantities of the problem.

The question being considered from this new point of view, our unknown quantities will be: 1. The correction of the flattening at the poles, or the eccentricity of the terrestrial meridian. 2. The mean coefficient of the dilatation of substances which constitute the superficial crust of the earth.

We will use, for this purpose, the principal determinations as given in the following table, in which also is indicated the country in which these arcs were measured and the latitude of their middles.

Nos.	Countries.	Degree Measured.	Latitudes.
1	Equator	110,582^m.1	− 1° 31′ 00″
2	India	110,627 .2	+13 6 31
3	Good Hope	111,163 .0	−33 18 30
4	United States	110,880 .0	+39 12 00
5	Italy	111,054 .0	43 10 00
6	France	111,125 .7	44 51 2
7	England	111,941 .0	52 33 45
8	Prussia	111,377 .0	54 58 26
9	Russia	111,362 .0	58 17 37
10	Sweden	111,488 .5	66 20 10

Now, a being the radius of the equator and e the eccentricity of the meridians, we have according to Bessel: $a=6,\ 377397^{m}$; $e^{2}=0,\ 006674$.

With these elements, and designating by l the latitude of the middle of the arc, the length of a degree of the meridian can be calculated by the following formula. (See our *Traité de Topographie, Geodésie et Astronomie*, vol. II, p. 228.)

$u=G(1-Ae^{2}-Be^{4})$, in which we have: $G=3600\ a\ sin.\ 1''$; $A=1-\frac{3}{2}\ sin.^{2}l$; $B=\frac{3}{4}\ sin.^{2}l-\frac{1}{8}\ sin.^{4}l$.

If we apply these formulæ to each of the latitudes of the preceding table, we will obtain the calculated values u of the corresponding degrees seen in the following table. They differ more or less from the measured values, which we designate in general by m. The last column of the table gives the differences $m-u$ between calculation and observation.

Nos.	A	B	u	m	$m-u$
1	+0.99893	+0.0010	110,564^{m}.5	110,582^{m}.1	+ 17^{m}.6
2	+0.99284	+0.0722	110,620 .7	110,627 .2	+ 6 .5
3	+0.54706	+0.2818	110,898 .0	111,163 .0	+265 .0
4	+0.40061	+0.3000	111,007 .0	110,880 .0	−127 .0
5	+0.29708	+0.2913	111,083 .8	111,054 .0	− 29 .8
6	+0.25391	+0.2822	111,116 .6	111,125 .7	+ 9 .1
7	+0.05846	+0.1909	111,265 .9	111,241 .0	− 24 .9
8	−0.00589	+0.1627	111,310 .2	111,377 .0	+ 66 .8
9	−0.08567	+0.1084	111,369 .7	111,362 .0	− 7 .7
10	−0.25835	−0.0612	111,498 .8	111,488 .5	− 10 .3

It may be noticed at once that the degree of the Cape of Good Hope, which was measured by La Caille, is that which gives the greatest difference $m-u$, and indicates, by the positive sign, that the curve of the meridian at the latitude of about 33° seems to be less pronounced than it would be upon an ellipse. This fact, which accords with our theory in a remarkable manner, has led some geodesists to admit that there exists an abnormal depression of the surface of the earth toward that latitude, in the southern hemisphere. Such a difference ought not to be attributed to errors of observation, since La Caille, himself, surprised at the result of his work, repeated most of the operations without being able to make it disappear; and besides the incontestable skill of this geometrician, and the identity of his methods with those which have been employed in nearly all the operations relative to the measurement of the earth, give great force to the presumption of a depression of the earth toward the third of the quadrant of the meridian, that is, toward the same point where our theory of dilatation placed it. We believe ourselves authorized to think that this remarkable coincidence between a theoretical indication and an experimental fact, is not perhaps the simple effect of chance.

It is true that the fourth arc of our table measured in America by Mason and Dixon, at a latitude a little greater, produces a difference $m-u$ negative and quite large, but we do not believe our law to be less tenable on that account, not only because that difference is not half so great as the other, but also because the American arc is the only one which was measured by the application of a unit of

length upon the ground, while all the others have been valued by means of trigonometric operations, less subject, in general to important errors.

However that may be, remove from our combination the two arcs which give the greatest differences between the calculation and the observation. It may be seen just the same that the degrees of the equator and of India, that is, the warmest countries of the globe, give difference $m-u$ positive, indicating that the lengths which are measured are longer than those which are calculated. The last two arcs of the table, measured in Lapland and in northern Russia, give on the contrary negative differences, and the two facts united, are in our eyes, eloquent in favor of the appreciable influence of the temperature.

According to what we have said, and in accordance with the nature of that research, we will form equations of condition established upon the hypothesis that every difference proceeds from a small error of the element e^2 of the ellipsoid—the effect of the temperature upon each arc measured. Calling x the correction of the square of the eccentricity, the correct value of the calculated arc would have for expression: $u=G(1-Ae^2+Ax-Be^4)$. Since this correction is very small by hypothesis, and the term Be^4 has no appreciable influence we can write: $u'=u-AGx$. As to the measured arcs, we will suppose them reduced to the same temperature, as is always done when one wishes to compare the lengths of dilatable bodies; but, in the actual case, it is not perhaps proper that the common temperature be 0°, because it is not useful to calculate at 0° the dimensions of a body which, in its entirety, is never at that temperature, and we will adopt rather that of 10° C. In effect, since the mean temperature is 25° to 30° near the equator, and −8° to −10° near the poles, we may say, with sufficient exactitude, that the mean of the entire globe is not far from +10°.

Suppose, then, that each arc, measured at a certain temperature t, has a length equal to that which it would have at 10°, augmented by the quantity $m(t-10°)y$, which expresses the effect of dilatability for $t-10$ degrees of heat, y being the mean coefficient of dilatation of the substances which constitute the crust. In consequence, $m-m(t-10)y$ will represent the length at the common temperature; and as, all corrections being made, the calculated degree ought to equal the measured degree, we will have:

$$u-AGx=m-m(t-10)y, \quad \text{or:} \quad -AGx+m(t-10)y=m-u.$$

Each degree will give rise to the establishment of an equation of the same form between the unknown quantities x and y, by means of which we can easily obtain their values. It will be understood, however, by inspection of the coefficients and by the nature of the corrections, that the unknown quantities should be very small in relation to the coefficients, so that, for the convenience of the numerical operations, it seems to us preferable to adopt another system of unknown quantities depending on the preceding. For this purpose we make:

$$p=10000x \qquad P=\frac{AG}{10000} \qquad\qquad q=100000y \qquad Q=\frac{m(t-10)}{100000}$$

and the equations of condition will take the form: $Pp+Qq=m-u$.

For lack of reliable data concerning the true temperatures of the ground in the places where the arcs of the meridians were measured, we will replace them by the mean temperatures of the air which we have taken upon a chart of isothermal lines for the latitude of each of the arcs. They are:

	t	$t-10$
For the Equator	24°	+14°
" India	28	+18
" Italy	15	+ 5
" France	12	+ 2

	t	$t-10$
For England.....	9°	− 1°
" Prussia.....	8	− 2
" Russia.....	3	− 7
" Sweden.....	0	−10

Our eight equations will be:

$$-11.119p+15.481q=+17.6 \qquad -10.272p+19.913q=+\ 6.5$$
$$-\ 3.317p+\ 5.553q=-29.8 \qquad -\ 2.826p+\ 2.223q=+\ 9.1$$
$$-\ 0.595p-\ 1.112q=-24.9 \qquad +\ 0.066p-\ 2.228q=+66.8$$
$$+\ 0.953p-\ 7.795q=-\ 7.7 \qquad +\ 2.876p-11.149q=-10.3$$

The number of these equations being greater than that of the unknown quantities, they may be combined in several ways.

The method of Mr. Mayer which consists in making the sum of all the equations, after having given the same signs to the coefficients of the same unknown quantities, furnishes for final equations:

$$32.024p-63.230q=+70.3 \qquad 30.834p-65.454q=+20.5$$

of which the solution produces $p=+22.57$ and $q=+10.32$. Consequently we have: $x=+0.002257$ $y=+0.000103$.

If we reject the equation of the Prussian degree, as discordant in relation to the others, the final results will be:

$$31.958p-61.002q=+3.5 \qquad 30.708p-63.226q=-46.3$$

From which it results: $p=+21.20$ and $q=+11.05$, and we will have

$$x=+0.002120 \qquad y=+0.000110$$

It is worthy of remark that this arc presents a special interest because the latitude of its center is almost that which reduces to 1 the coefficient $1-Ae^2-Be^4$, and could, consequently, furnish the value of the equatorial radius independently of that of the eccentricity. In effect, placing $A+Be^2=0$, we will have:

$$sin.\,l=\pm\sqrt{-0.4\frac{1-e^2}{e^2}+\sqrt{\frac{8}{15e^2}+\left[0.4\frac{1-e^2}{e^2}\right]^2}}$$

which for $e^2=0.006674$, produces $l=54°\ 43'\ 47''$. With this value of l we will have:

$$a=\frac{m}{3600\ sin.1''}$$

As the Prussian arc realizes almost exactly this condition, it could be employed for the determination of a to obtain a value in which the influence of a small error in e^2 would be insensible. In proceding thus, this arc will give the equatorial radius greater than that which results from Bessel's discussion.

Another combination, which presents itself naturally to the mind, is that of the two first equations with the two last, as representing the extreme effects of the temperature and even of the eccentricity, since the former are connected with the measurements made near the equator, and the latter with the operations at the highest latitudes. By this combination we will have:

$$25.220p-54.338q=-42.1 \qquad 17.562p-10.450q=-6.1$$

These equations are respectively formed by the numerical sum and the algebraic sum of the four primitives, the change of sign for an unknown quantity being impossible more than once, without changing at the same time the sign of the other; but the combination will give the same result as if we had taken the sum of the two first equations of condition and that of the two last. Their solution produce: $p=+0.67$ and $q=+1.09$, and we will obtain consequently:

$$x=+0.000067 \qquad y=+0.000011$$

We might equally well solve the equations of condition by the method of least squares; but the results would not be very different from the previous ones,

and we believe that the execution of long calculations with the approximate data which we were obliged to employ would be of very little use. It is sufficient for our object that all the combinations made produce positive values of x and y. Since this fact indicates that, the earth being considered as a solid of revolution, its eccentricity is increased, when we take into account the effects of the temperature, and that these effects are very appreciable. We can believe then, in view of these indications, that if we effect the combination of geodetic measurements by the methods which we have followed, and with data of temperature more worthy of confidence, we might diminish greatly the discordances which may be now found between the different geodetic measurements and that which has been deduced from the measures with the pendulum.

The value of the eccentricity which results from the first combination which we made, taking as mean $x=+0.002188$, is $e^2+x=0.008862$, which gives a polar flattening of $\frac{1}{226}$,—without doubt too large a quantity. The second combination, that is, that of the two arcs of the intertropical region, with the two which are the most northern, gives $e^2+x=0.006741$, and a flattening of $\frac{1}{295}$,—a little greater than that obtained by geodesy and smaller than that obtained by the pendulum. The mean of the two combinations will give $\frac{1}{256}$ for flattening, value a little greater than that of $\frac{1}{305}$ furnished by the pendulum.

As to the mean coefficient of dilatation of the substances which compose the superficial strata of the earth, the first combination gives $y=0.000106$, a quantity from five to six times greater than the coefficient of dilatation of copper, of bronze and of brass, and nearly 10 times greater than that of steel. The other combination produces $y=0,000011$, a result nearly 10 times smaller than the first, and which is almost the coefficient of iron, and much greater than that of glass and platinum.

We believe, however, relying on the fact that the least dense bodies are in general the most dilatable, that the minerals constituting the soil, and of which the mean density does not probably exceed 3 or 3.5, should have a coefficient dilatation perhaps superior to that of most of the metals in a state of purity.

It must not be forgotten that in our calculations, we have only employed the mean temperatures of the air, but that the soil experiences much greater changes of temperature, and that it is not diathermanous like the atmosphere. The custom which prevails almost everywhere of observing only the temperature of the air, is, in our opinion, the cause of the lack of clearness in the ideas that prevail in general concerning the enormous quantities of heat which the soil receives during the presence of the sun above the horizon, and the limits which it may reach.

In the first months of this year, we made, at the City of Mexico, some comparative observations, from hour to hour of the temperatures of the air and soil. The first was measured in the ordinary manner with a thermometer suspended $1^m.60$ above the soil in a place quite uncovered, although in the shade; and the second with another thermometer placed horizontally upon the earth and exposed to the direct rays of the sun. We are going to place before the eyes of the reader the two extreme series, that is, those which respectively represent, nearly, the coldest day and the hottest day of the year at Mexico. All the temperatures are expressed in centigrade degrees:

Feb. 10, 1881.				April 19, 1881.			
Hours.	Air.	Soil.	Diff.	Hours.	Air.	Soil.	Diff.
7h	+ 1°.4	− 3°.0	− 4°.4	7h	13°.0	15°.5	+ 2°.5
8	3 .5	+ 6 .7	+ 3 .2	8	17 .2	26 .5	9 .3
9	8 .6	18 .0	9 .4	9	20 .7	36 .0	15 .3
10	13 .4	28 .0	14 .6	10	23 .9	44 .2	20 .3
11	16 .6	35 .0	18 .4	11	26 .4	49 .5	23 .1
Midday	20 .5	40 .4	19 .9	Midday	27 .5	51 .0	23 .5
1	22 .5	39 .9	17 .4	1	30 .0	52 .0	22 .0
2	23 .9	39 .6	15 .7	2	29 .4	50 .0	20 .6
3	24 .2	37 .0	12 .8	3	30 .6	47 .0	16 .4
4	23 .9	32 .0	8 .1	4	30 .0	40 .0	10 .0
5	21 .1	24 .0	+ 2 .9	5	29 .0	31 .0	2 .0
6	17 .5	16 .5	− 1 .0	6	25 .0	24 .0	− 1 .0

It may be seen from these numbers that in the course of a day, in our intertropical regions, the soil experiences changes of temperature of at least from 30° to 40°, so that even in supposing the mean coefficient of dilatation equal to the smallest of our results, to wit: $y=0.00001$, it will produce an oscillation of 30^m to 40^m in the length of a degree of the meridian. It seems to us in consequence impossible that we should neglect longer effects of such importance; and we can not explain how it is that the geodesists have neglected it up to this time. It is, perhaps, the principal cause of the discordances, which the geodetic operations most worthy of confidence present among themselves, and between these and the results of the observations with the pendulum.

Nothing of what we have said signifies that, in our opinion, the earth is a perfect solid of revolution it has without doubt very appreciable irregularities, were it only because of the unequal distribution of land and water; but it seems to us that it must approach that form, although its generator is not exactly elliptical. If our theory is well founded, it shows that the meridian is not a perfect ellipse; but on the contrary, there are certain depressions relative to the equatorial swelling produced by the constant action of solar heat.

(To be continued.)

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LITERARY NOTES.

—The *Proceedings of the Missouri State Board of Health*, July 8-10, 1884, contains general rules for sanitation and a paper on hog cholera. The last is by Dr. W. B. Conery, and gives adhesion to the germ theory of this disease.

—We have received from Prof. J. B. Davis a pamphlet entitled *Public Water Supply and Water Works*, by W. R. Coats, C. E. The pamphlet contains 41 pages filled with various papers, articles, and reports by the author, originally published elsewhere in various periodicals and brought together here. Mr. Coats' fundamental idea is that the proper source of city water supply is the level of secondary subterranean drainage. The first level supplies wells and is found to be contaminated by organic matter. The third is the source of supply for artesian wells and here the water is contaminated with mineral matter. Between these is Mr. Coats' secondary layer and here he finds the water relatively pure so far as concerns both organic and inorganic matter. The principal bearing on problems of scientific interest which this theory has, is as to the direction of spread of organic matter through subterranean waters. Mr. Coats considers it essentially horizontal and the experiments he quotes substantiate this. It seems however to need fuller confirmation, as the direction of spread must depend on the lay of surface strata. When these are horizontal, the spread must be the same.

—The first volume of the *Geological and Natural History Survey of Minnesota*, which has just appeared, relates to the geology of the state. It is a very creditable volume and Prof. N. H. Winchell, the director, is to be congratulated on having made the substantial progress represented here. Of interest to our readers are, besides some references to climatic changes, the abstract and maps of early explorations of the Upper Mississippi River.

—The *Annals of Mathematics* for May (which reached us in August) maintains the high order of excellence with which it started out.

—In the reports of the *Alabama Weather Service*, oftener than elsewhere, we find accounts of severe local storms passing through the air but not reaching the ground. Thus we learn in the July report that at Trinity, on the 5th, at 6 P. M., "an angry looking cloud came up from the Northwest, with vivid lightning and strong wind. It passed over us with a noise like that of a heavy freight train, but seemed to be above us. No damage was done in this vicinity and comparatively little rain fell." We are in doubt whether such phenomena are more common there and or are simply more carefully observed.

—From the *Monthly Weather Review* for June we learn that the areas of low barometer for this month were few in number and of slight intensity. Their paths are remarkably tortuous and they lingered long in the mountains. All of these characters belong to the summer areas of low pressure. Of the six areas only two (one of them formed by the junction of two in Colorado) reached the Atlantic.

One disappeared from view in Arkansas another in Dakota. It is not likely that these were lost as the region in which they disappeard is satisfactorily supplied with observing stations. On the other hand they lost their energy and the depression was smoothed out. We say this apropos of some public teachings to the effect that these areas are practically atmospheric satellites. The disappearance of these centers in plain view and their devious course negative in a decided manner the theory of their persistence in regular paths. None of the continental areas could be associated with the Atlantic ones. Of the latter only four were noted and they were mild.

At Phœnix, Arizona, the maximum temperature for the month was 114°, the minimum 48°. On Pike's Peak the extremes were 44° and 19°. The highest temperature observed was 115° at Maricopa. The greatest monthly range was in Arizona where it reached 74° at Willcox and 66° at Phœnix, the smallest was at Cape Mendocino and San Francisco where it was 18° and at Key West where it was 19° The daily ranges varied from 16° at New Orleans to 55° at Fort Apache, Arizona. The lead taken by Arizona in these ranges is striking. The highest temperature yet recorded for June was at Fort Mojave in 1876 where the temperature rose to 119°. Fort Mojave is also in Arizona.

The region of greatest precipitation moved eastward from eastern Texas of last month and now occupied Northern Georgia and parts of neighboring States. The precipitation was however so scanty as to be injurious in many of the Northern States and in Texas.

Slight shocks of earthquake in California and a family of nine waterspouts off Key West complete the more interesting features of this report.

—The *Michigan State Board of Health*, publishes a weekly statement of the health of Michigan and abstract of the weather at Lansing. It also furnishes the meteorological data for the monthly crop report of the Secretary of State. In its annual report, the results of its meteorological observations in the State are published in some detail. We have, in advance of the complete report, the part just referred to, printed in pamphlet form, and entitled *Principal Meteorological Conditions in Michigan in 1882*. It is based on the monthly reports of tri-daily observations made at 31 stations, of which six are of those of the Signal Service. The pamphlet contains 76 pages and 15 diagrams. This, with the long row of its predecessors, makes a valuable contribution to the meteorology of the State. The only criticism we venture to make is that, in our opinion, the diagrams could be much improved in attractiveness and clearness by making the curves lighter and not putting so much in a single diagram.

—Vol. I of the *Publications of the Washburn Observatory*, contained the meteorological data for 1872–81, inclusive, and Vol. II, just issued, continues the data for 1882 and 1883. They were derived from the observations of the U. S. Signal Station until April 1st, 1883, when the station was abandoned by the Signal Service and the instruments turned over to the University of Wisconsin. Since then tri-daily observations have been continued by the observatory. A summary of meteorological observations is given for from 1853–1883, by months. A list of 38 auroras seen in 1881–3 at Madison is given and Lueders' list at Sauk City, already noticed in this journal, is incorporated in this volume. Of the 38 auroras at Madison, 17 were not seen by the indefatigable observer at Sauk City, though many of them are noted as bright. In many cases this may have been due to cloudiness.

—Captain P. Hoffman's *Zur Mechanik der Meeresströmungen an der Oberfläche der Oceane*, (Berlin, 1884, 8 vo., VI+99pp.), has some features of great interest. The author thinks that the chief cause of oceanic currents or drifts is to be found in the wind while the other causes are subordinate. After pointing out the difficulties in obtaining satisfactory observations of oceanic movements in open water, he proceeds to show that not only can a long continued wind produce a surface current with a velocity continually approaching that of the wind, but that this current may extend to a depth which is also a function of the time, and also that it must give rise to return-currents below and at its sides. Next in importance for its effects on ocean currents is, according to the author, the configuration of the coasts and in this connection he gives a brief account of Zöppritz's important hydrodynamic studies in Wiedenmann's Annalen. Next comes the influence of the earth's rotation and the author gives several simple demonstrations of its effects. The other causes, evaporation, differences of density, changes in atmospheric pressure, etc., to which recent authors have been disposed to give great prominence, Captain Hoffman considers of very subordinate value. The author then proceeds to discuss the various currents and finds that they are sufficiently accounted for by his principles. Those of the Arctic and Antarctic regions are, he thinks, not sufficiently known to afford safe general conclusions, but he is sure that the Kuro-Siwo and Gulf Stream do not send up branches from their Western margins in the Arctic Ocean. The whole forms an interesting addition to the discussion of ocean currents and is put in a form which can be understood by readers with little mathematical training.

—Mr. Edmund B. Weston, C. E., sends us the *Annual Report of City Engineer of the City of Providence* for 1883. The department has a good outfit of instruments and keeps a continuous record of observations. Among the instruments are self-recording barometer, anemometer and anemoscope. The observations are given for the hours of 7, 1 and 9 with maximum and minimum of pressure and temperature. We reprint the table of annual precipitation which includes a period of more than 50 years.

Year.	Fall in Inches.	Year.	Fall in Inches.
1832	39.46	1858	44.51
1833	34.14	1859	45.16
1834	41.92	1860	38.44
1835	30.96	1861	44.25
1836	37.87	1862	50.14
1837	31.62	1863	55.17
1838	37.88	1864	36.83
1839	36.75	1865	44.69
1840	41.19	1866	46.02
1841	47.86	1867	47.04
1842	37.71	1868	53.55
1843	42.50	1869	47.70
1844	35.00	1870	49.02
1845	43.16	1871	47.91
1846	30.51	1872	48.71
1847	48.50	1873	52.56
1848	40.48	1874	43.39
1849	34.69	1875	52.22
1850	51.49	1876	50.36
1851	43.38	1877	48.80
1852	38.58	1878	59.32
1853	53.27	1879	47.57
1854	46.25	1880	48.38
1855	39.05	1881	52.96
1856	40.97	1882	51.84
1857	44.75	1883	45.71

The observations to 1876, inclusive, were taken by the late Prof. A. Caswell,

and those from 1877 to 1883, inclusive, were taken at the Providence Water Works.

—The monthly *Meteorological Charts of the North Atlantic Ocean*, is a very instructive and interesting series issued by the Hydrographic Office. All the months are now represented except December. The publication began in June 1883 and has continued to the present. We may expect the December number before long. On the charts each square formed by meridians and parallels for each ten degrees has a graphical representation of the meteorological elements as derived from trustworthy reports of navigators. The method of representation has been skillfully chosen, with special reference to filling the space and bringing into prominence the data especially interesting to seamen. The whole forms an easily read compend of the meteorology of the North Atlantic of great interest from both the practical and theoretical points of view. Meteorologists can not afford to be without them and we understand that they are for sale at a very moderate cost.

—The report of the Weather Service for July is to be found in the *Tennessee Crop Report* for that month. The service is evidently having a healthy growth. The number of observers who report for this month is 47 as against 36 in May. There were many thunderstorms, some severe, and in many cases some details of them are given. Mr. S. P. Ferguson, of Riddleton, reports a detailed study, at intervals of a few minutes, of the temperature, wind, and upper and lower clouds for the thunderstorm of July 5th. The interest of the study would have been very much increased by including the barometric pressure.

CORRESPONDENCE.

A SINGULAR TWILIGHT PHENOMENON.

To the Editor:—While observing the western heavens after sunset on Thursday evening, Sept. 11th, at about half past six o'clock (local time), I noticed a peculiar, and, to me, *a new phenomenon*, associated with the strange twilight-glow so frequently seen of late; and an account of my observation will doubtless be of interest to your readers in connection with the "red sunsets" which have recently attracted so much attention. Shortly after sunset on the evening above mentioned, the western sky began to be gorgeously illuminated with most of the rainbow-tinted colors of the solar spectrum, and as the sun continued to descend below the horizon, twilight deepened, and the red glow became more conspicuous, until the whole sky in the west presented the appearance of a vast conflagration. Then the sky near the horizon, as darkness began to approach, became of a deep green color, presenting a fine appearance as it blended with the beautiful foliage of the trees. Resting upon the green, which formed a belt extending parallel with the horizon, was a brilliant scarlet, *in the form of a pyramid*, with its base toward the horizon, presenting a somewhat striking resemblance to the Zodiacal Light, usually seen in the west during the months of February and March. The illumination extended to a height of 65 or 70 degrees, with its apex just west of the zenith, its position, form and extent being *nearly identical* with the mysterious glow of the Zodiacal Light, as it appears in March, when generally the most conspicuous.

The sun had set only about twenty minutes when I noticed the strange phenomenon, and I saw but four stars that

were visible at the time—Arcturus, Vega, Altair and Antares—so it was at least half an hour before dark when I first observed it. I watched it carefully for about three minutes, when the singular illumination began to fade, until it apparently dissolved and finally disappeared. Though of such brief duration, the most remarkable circumstance that particularly attracted my attention, and excited my curiosity from the first, was the form it assumed, the outlines of which could be distinctly traced against the less brilliant background of the sky. In fact, *the pyramidal form was the most striking feature* of the phenomenon, as I never heard of it having been noticed by anyone, and never myself witnessed such an appearance before, or anything in the heavens resembling it, associated with the twilight, though I have for many years been a frequent observer of the western sky after sunset: and, as it so closely resembled the Zodiacal Light in appearance, the question has suggested itself to my mind whether it may not, in some way, be connected with that mysterious phenomenon, which, at this season of the year, is never seen except in the east before sunrise, in the early morning twilight. Before the illumination began to assume the form I mention, all the prismatic colors of the twilight had gradually vanished, except the red and green, which predominated from the first; and during the continuance of the pyramidal phenomenon, the green became darker, and the red changed to a brilliant scarlet, no other colors having been visible at the time, and the singular form I have described was assumed as suddenly as it disappeared.

From the commencement of twilight the rainbow colors were arranged in their proper order, according to the well known laws of dispersion, the red being *above* the green, as it should be, and furthest from the horizon instead of nearest, as Dr. Murrell, of Little Rock, Ark., states that he saw it, in his observation described in this JOURNAL for Sept., p. 191. When I observed the phenomenon referred to, the western sky was quite free from clouds, except very near the horizon, and at a higher altitude only a slight, transparent haze was visible, presenting a noticeable contrast to the atmospheric conditions mentioned by Dr. Murrell. In my observation the red was the last color that vanished, as is usually the case in all twilight phenomena, owing to its greater power of penetration; but Dr. Murrell makes the surprising statement that, "As dark approaches, the red end of the spectrum first disappears, then the other colors in order, leaving violet as *the last visible color* of the red sunset," which is contrary to the usual phenomena of colors seen in our evening twilight, as is also the reversal of the rainbow colors noticed in the observation which he has described. I have never seen the twilight under the conditions mentioned by him, and as he does not allude to the pyramidal illumination to which I refer, I conclude that he has never observed such a phenomenon, but if it has ever been recognized by any other observers, I should be glad to know. I have never seen any reference to it in meteorological literature, nor heard of any observation of the phenomenon.

My opinion is that the red sunset phenomena are due to a *combination* of causes, and that the "watery vapor" theory alone is insufficient to account for the appearances observed. Dr. Murrell says, in the September JOURNAL: "Of all the theories offered for the red sunsets, that attributing it to moisture in our atmosphere seems most consistent with the phenomena." But I think the red glow itself can be more satisfactorily accounted for, and all the observed phenomena fully explained, if we assume that it is produced by a *dry fog* or *phosphorescent mist* in our atmosphere, similar to the conditions which prevail during our so-called "Indian Summer"; and the red sunsets, with their various phenomena, may to a certain extent be due to the presence of volcanic dust, or some cos-

mical matter foreign to the earth and its atmosphere. But whatever may be the cause of our remarkable sunsets, I consider either of the above mentioned causes *alone* inadequate to produce the singular phenomena observed. There are many instances on record when all the phenomena which characterize our red sunsets have been witnessed during the prevalence of a dry fog or mist such as I have mentioned, and it is singular that these possible causes have been overlooked, or disregarded, by those who have advanced theories to account for the appearances under consideration. I have seen no reference to the atmospheric conditions to which I allude, except in Loomis' "Treatise on Meteorology," in which those who favor the "volcanic dust" theory of our red sunsets will find sufficient material to support and give additional weight to their views. On p. 100, art. 185, he says: "Sometimes a dry fog continues for several weeks, and prevails over a vast area, exhibiting very peculiar characteristics. These fogs have been ascribed to the presence of *fine volcanic ashes* in the atmopshere, and perhaps also of substances foreign to the earth. In 1783 such a fog prevailed all over Europe, and continued for more than a month. It was *preceded by a remarkable eruption of the volcano Hecla*, in Iceland, which for a long time emitted smoke of unusual density. In 1831 a similar fog prevailed in the United States, in Europe, and on the coast of Africa. It obscured the air to such an extent that the sun could be observed all day with the naked eye, without the interposition of any colored glass. At night the fog seemed *decidedly phosphorescent*, and emitted an *appreciable amount of light*, which could not be ascribed to the reflected light of the stars."

While I believe the usual phenomena of the red sunsets can thus be adequately accounted for by the theory of volcanic dust, superadded to that of moisture, and possibly cosmical matter in the earth's atmosphere, I cannot understand how any of the above theories could be sufficient to account for the strange pyramidal illumination which I have described, and I can think of no explanation for a phenomenon so startling and mysterious, unless it be attributed to the same unknown cause that produces the Zodiacal Light, and in which the Solar Corona may possibly have its origin. It was certainly no electrical phenomenon to be compared with the aurora; but whether it can be regarded as an optical phenomenon associated with our atmosphere, or one of cosmical origin, I am not prepared to say, and it would be an interesting subject for meteorologists to investigate. The recent phenomena of our red sunsets afford some important material for study, and suggest many perplexing questions for meteorological students to answer.

Very respectfully yours,

ARTHUR K. BARTLETT.

BATTLE CREEK, MICH., Sept. 18, '84.

A METEOR.

TO THE EDITOR:—About 9 o'clock on the evening of August 19, being at North Wales, Pa., (22 miles northwest of Philadelphia), my attention was called by a companion to a bright meteor which was visible for 3 or 4 seconds, and which left a luminous train lasting ten seconds or longer. I saw the meteor in time to witness the greater portion of its flight. It first appeared, as my companion pointed out, near 23 Ursae Majoris, and passing between "the pointers" in that constellation and a little below *Gamma* (rather less than 10° estimating from memory), it vanished when about south of Epsilon Ursae Majoris, or nearly in 13^h right ascension.

The train seemed to lose its brightness a little sooner than the meteor, so that when the latter disappeared, which it did quite suddenly, the train was but a feeble line of light for a distance of the first 4 or 5 degrees, then where it was more brilliant it slowly broadened out to a degree or more in width by the dispersion of the

luminous matter, the whole extending about 25 degrees in length, and, without the feeble part adjacent to the meteor, presenting quite perfectly the form of a very elongated ellipse.

The meteor presented no perceptible disk, but was five or six times brighter than Venus at her greatest brilliancy. It was undoubtedly one of the Perseids, though considerably out of the beaten track. Another faint meteor, apparently from the same source, was seen a few minutes later. GEO. B. MERRIMAN.

NEW BRUNSWICK, N. J.

PUBLISHERS' DEPARTMENT.

CORRECTION.

On page 170, line 25, in Gilbert's article on Finley's Tornado Predictions, read o, $-s$ instead of $o-s$.

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For Calendars, or for information concerning the University, apply to

JAMES H. WADE,
Steward of the University.

Ann Arbor, Mich., Oct. 1st, 1884.

PROSPECTUS OF THE FORTNIGHTLY

1884. INDEX 1885.

AN INDEPENDENT JOURNAL OF LIBERAL EDUCATION.

A plan has long been in contemplation to establish at Ann Arbor, the seat of the University of Michigan, a journal of high character, that should reflect the maturest thought on educational, literary, scientific, artistic, political and historical questions of current interest. The presence and the influence of this great center of learning seemed to afford unusual facilities for carrying forward such an enterprise; and it was felt that an institution of so great influence in moulding the education of the West should have some recognized medium of communication with the leading teachers and scholars of the country. Through a series of steps not necessary here to describe, the fortnightly INDEX, now entering upon its third year, finds itself in a position to undertake the mission just indicated; and the attention of the educational public is invited to the announcement we now have to make.

By an arrangement recently completed with Professors Alexander Winchell, Charles K. Adams and William H. Payne, of the University of Michigan, these gentlemen have been added to the editorial staff of the INDEX; and the paper will be conducted hereafter in accordance with the following general plan:

I.—*Alexander Winchell, LL. D.*, Professor of Geology and Palæontology, will take in charge the department of Science and Arts, and by way of editorials, notes and leading articles will present regularly a careful digest of whatever is most valuable in these important domains of knowledge. There is a growing recognition of the value of science in all schemes of public education; and Dr. Winchell will discuss the various phases of scientific intelligence and instruction.

II.—*Charles K. Adams, LL. D.*, Professor of History, and Dean of the School of Political Science, will write upon current affairs and upon such Historical themes as bear on matters of present political and educational importance. He will also discuss another class of subjects now assuming a deserved prominence —the training of the young for the duties of citizenship through suitable instruction in Political Science; and the need of diffusing among the people at large correct ideas on governmental and municipal administration.

III.—*William H. Payne, A. M.*, Professor of the Science and the Art of Teaching, will discuss the subject of Education in its three phases, the practical, the scientific and the historical. The treatment of these themes will be catholic and impartial. The purpose will be to expound the rational elements in scholastic questions, and to ally the methods of the school room with common sense as well as with philosophy.

IV.—The *Literary Department*, remaining in the same hands as heretofore, will continue to maintain a high standard of excellence. A trustworthy record of the latest publications will be presented; and a series of leading essays, and short poems of merit will be made prominent features.

V.—The *Department of Criticism* will be conducted in a spirit of judicial independence. Exhaustive review articles, and extended notices of important works and events of the realm of Art, written by specialists in their several lines, will express the critical judgments of men qualified to form an unbiased opinion.

VI.—*Letters from Foreign Correspondents* will contain intelligence of progress in different parts of the world. We shall allow our home correspondents ample space for the discussion of all questions that fall within the compass of a high class educational and literary journal.

VII.—The INDEX will be issued fortnightly, the subscription price remaining as before—$2.00 per year, prepaid. The publishers are encouraged to solicit subscribers among all persons interested in the maintenance of an independent journal of liberal education such as the INDEX, upon the broad plan here outlined, aims to be. For the present all subscriptions may be sent directly to the

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